# Novel Non-Intrusive Vibration Monitoring System for Turbopumps, Phase II

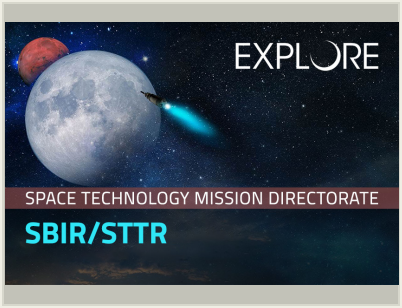
Completed Technology Project (2006 - 2007)

## Project Introduction

ASRI proposes to develop an advanced and commercially viable Non-Intrusive Vibration Monitoring System (NI-VMS) which can provide effective on-line/off-line engine vibration monitoring capabilities without relying on intrusive key-phasor speed measurements. Many powerful vibration signature analysis techniques for engine-health monitoring rely on key-phasor signals to extract/enhance critical fault signatures from noisy vibration measurements. In many situations (e.g. SSME HPOTP), such speed measurements are not available, usually due to the safety concerns of a key-phasor's intrusive installation (e.g.in a high-pressure liquid-oxygen environment for HPOTP). As a result, the ability/reliability for health monitoring and post-test diagnostic evaluation is severely limited. The proposed NI-VMS overcomes this problem by utilizing a novel signal analysis technique called Pseudo Key Phasor (PKP) to reconstruct a PKP signal directly from external vibration measurements. This procedure enables powerful signal analyses that require a key phasor to become applicable, greatly enhancing fault detection and diagnostic capabilities. NI-VMS can reduce the risks of catastrophic engine failure and improve the reliability of NASA's current/future propulsion systems. Phase I feasibility studies using SSME test data have successfully demonstrated the technical merits of NI-VMS. Phase II will complete design, development, and testing of the prototype NI-VMS hardware/software system.

## Anticipated Benefits

Potential NASA Commercial Applications: NI-VMS has significant applications in commercial/DoD transportation, power generation industries, and the manufacturing sector where many aircraft/plant engines/machinery are not instrumented with key phasor due to safety/cost concerns. NI-VMS's unique capability in performing non-intrusive monitoring will exert a strong appeal for these industries to use it to meet industrial and commercial health-monitoring requirements in reducing the risks of catastrophic hardware losses and plant downtime. Benefits to U.S. industry will be realized through contributions to safer aircraft/spacecraft propulsion, more efficient power generation, reduced downtime, and reduced operation and maintenance costs.

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## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Marshall Space Flight Center (MSFC)

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

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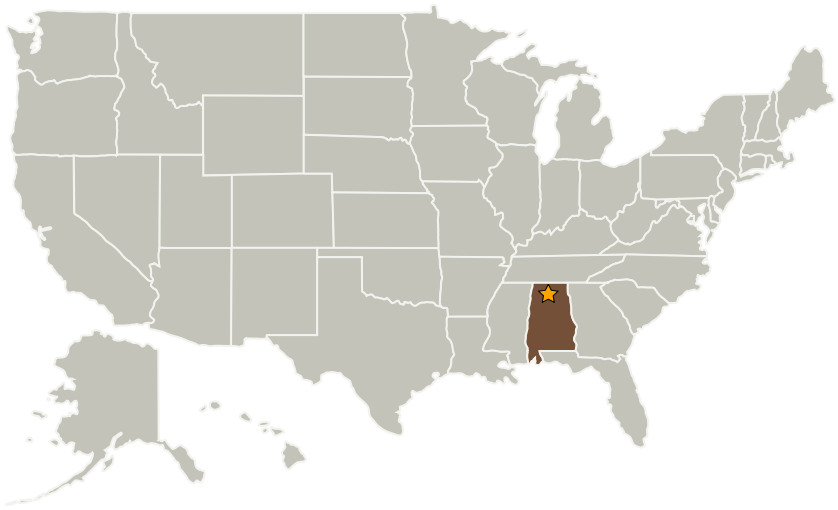
## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ★Marshall Space Flight Center(MSFC) | Lead Organization | NASA Center | Huntsville, Alabama |
| AI Signal Research, Inc. | Supporting Organization | Industry Minority-Owned Business | Huntsville, Alabama |

| Primary U.S. Work Locations |
|---|
| Alabama |

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Jen Jong

## Technology Areas

**Primary:**

- TX10 Autonomous Systems
  - TX10.2 Reasoning and Acting
    - TX10.2.5 Fault Diagnosis and Prognosis